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## KINESIOLOGY & COACHING

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# Comparison of Jumpıng-Landing Mechanics of Elite Handball andWrestling Athletes

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**Key words:** LESS, wrestling, handball, jump, acl

**Abstract**
Background. Examining and detecting the causes of injuries offers important contributions to athletes. Identifying the risk of non-contact injury in athletes and then directing them to preventive exercise programs may be beneficial for athlete health.
Purpose. This research aims to compare the jump-landing mechanics of elite handball and wrestling athletes.
Material and Methods. This research aims to compare the jump-landing mechanics of elite handball and wrestling athletes. In research in Bolu and Yalova provinces, 10 handballers in the 1st league(age 17.60±1.43 height 180.30±7.05 kilos 76.40±5.29) and 15 wrestlers on the national team(age 25.87±3.18 height 178.67±8.64 kilos. 77.13±14.16) , a total of 25 , male athletes volunteered. The Landing Error Scoring System (LESS) test protocol was applied to the athletes after the jump. Descriptive statistics of the athletes were made, and the Shapiro-Wilk test was used to determine the normal distribution of the groups. The non-parametric Mann-Whitney U test was used to compare handball and wrestling athletes.
Results. There was no difference between the LESS scores of handball and wrestling athletes ($p > 0.05$). Compared with the athletes' LESS assessments, significant differences were found in knee flexion angle at first contact, ankle plantar flexion scores at the point of contact, and knee valence displacement in the position of the thumb of the knee ($p < 0.05$).
Conclusions. In this study, which was conducted to determine the anterior cruciate ligament (ACL) risk level, there is no statistical difference between the LESS scores of wrestling and handball athletes. Despite this, the total LESS scores of wrestling athletes were found to be lower compared to handball athletes. This shows that the probability of injury is lower in terms of LESS score scoring. The fact that the result came out this way showed that the wrestlers who participated in our study had better lower extremities.

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## Introduction

Training is the ability and continuity of scientists, sports physiotherapists, sports psychologists, athletes, and coaches for their common athletic performances. Sporty performance can affect many factors, such as genetic predisposition, motor skills, psychological relativity, and physical fitness. Physical fitness that varies from branch to branch is very important for their sporty performance. Especially muscular fitness, body composition, coordination, strength, endurance, agility, curate, balance, and reaction time are considered important parameters. There are many factors that affect the outcome of the competition in combat sports [Ferguson 2014].

Sports injuries are another factor that affects athletic performance. In recent years, researchers have been striving to identify strong factors related to the occurrence of musculoskeletal injuries. Therefore, in some prospective studies, previous injuries [Arnason *et al.* 2004; Hagglund *et al.* 2006], age progression [Arnason *et al.* 2004; Hagglund *et al.* 2006; Henderson *et al.* 2010], poor flexibility [Ercan *et al.* 2021; Fousekis *et al.* 2011; Henderson *et al.* 2010], fatigue [Hawkins, Fuller 1999] and decreased muscle strength [Croisier *et al.* 2008; Engebretsen *et al.* 2010; Fousekis *et al.* 2011] associated with lower limb injuries.

In order to prevent physical destruction caused by high-violence training during the season, the size of the athletes should be evaluated by measuring at regular intervals. Training programming and motor characteristics of individual and team athletes may differ, but injuries may be common. Lower limb injuries are common problems seen in athletes. It can negatively affect individuals' performance or even make their physical activity stop for a long time. These injuries cause significant time losses for athletes. The most common lower-limb injuries are ankle and knee injuries. Factors such as wrong technique, joint movement limitation, flexibility level, and training situations can cause these injuries [Dai *et al.* 2019]. Sports branches such as handball and wrestling are sports branches where lower limb injuries can be exposed [Ince 2021].

In addition to being an Olympic sport, handball, a popular sport in Europe, played all over the world, has hard contact during training and competition, It is defined as a team sport, where athletes must have a physical exertion capacity to achieve short, high-violence movements [Bragazzi *et al.* 2020]. Speed performance, which is around 25% important in an elite handball player, is followed by bouncing and shooting power of 20% from other motoric features, 15% of endurance, flexibility, and coordination, and it is assumed that there is a general force at the rate of 10% [Gunduz *et al.* 2002]. Handballers have to use their lower and upper extremities very intensely during the game. The lower limb, especially in movements such as running, bouncing, and jumping; the upper limb works harder in movements that require strength and skill, such as shooting, holding, pushing, blocking, or goal shooting [Rinse 2014]. All these movements will cause athletes to be injured. Langevoort *et al.* [2007], in a study they conducted, found that the most common injuries in international adult handball tournaments affected the lower limb (42%), while the head (23%), upper limb (18%), and body (14%) were the next most common injuries.

Wrestling is among the contact sports. It is one of the branches that requires high strength, endurance, and agility. Elite wrestlers are subject to frequent and violent training as they must have a high-level physical profile [Chaabene *et al.* 2017; Thomas, Zamanpour. 2018]. For this reason, it brings with it the risk of both the contact struggles during the competitions and the physical burden injuries they are exposed to in training [Hewett *et al.* 2005; Kroshus *et al.* 2018]. Injuries in wrestling occur in the lower limb. The vast majority of these injuries occur at the knee.

The most accurate approach to sports injuries is to protect them from sports injuries. Where this is not possible, it is to minimize the risk of injury [Soligard *et al.* 2008]. Examining and detecting the causes of injuries makes significant contributions to athletes [Thin 2021]. It will be beneficial for athlete health to determine the risk of contactless injury for athletes in both sports branches and then direct them to preventive exercise programs. Large-scale research without expensive equipment can be an advantage for athletes and teams. LESS is a test that can be used to prevent sports-related lower limb injuries and identify individuals at risk. In this context, the purpose of this study is to compare the LESS test to be performed on athletes and the splash-landing mechanics of handball and wrestling athletes.

## Material and Methods

This research is a cross-sectional study. Ethical approval was obtained from the Ethics Committee of the University of Kocaeli Non-Interventional Clinical Research Study (E-80418770-020-321147). In our research, licensed athletes who are active in sports in Bolu and Yalova provinces took part. The athletes participating in the study had not previously experienced anterior cruciate ligament injuries. In accordance with our inclusion criteria, they have not experienced any disability that would impede their range of motion. 1. With 10 male handball players playing in the league (age 17.60 ± 1.43 size 180.30 ± 7.05 kilos 76.40 ± 5.29 training year 8.26 ± 1.16) and in the national team 15 male wrestling players ( age 25.87 ± 3.18 size 178.67 ± 8.64 kilos 77.13 ± 14.16 training year 8.10 ± 0.73) 25 athletes voluntarily took part. Athletes were applied to the Post-Bounce Ground LESS test protocol. LESS trials were scored independently by the authors.

### Landing Error Scoring System (LESS) Test

It is a system that includes examining three consecutive leaps in 17 items to determine the risk of contactless injury during jumping and landing movements. All athletes participating in the test performed a warm-up section containing yawning and running (low heart rate) before evaluations were made. A non-slippery wooden box with a height of 30 cm has been prepared for the splash. The splash protocol has been shown to the participants individually by the researchers. Participants were allowed to experiment at least once. No verbal motivation or command was given during the application. A target point marked on the ground is determined for each participant, half the length of the height. Athletes are expected to jump to the highest vertical height that they can jump without waiting after landing on the ground, with a half-length splash to the distance. This described bounce process was repeated three times in a row. During the LESS test, the jumps were recorded in the video recording. Two video cameras ( Basler 120Hz), one positioned to record front-plane movements and the other to record sagittal-plane movements, were used for testing. Padua *et al.* with Ercan *et al.* As stated in his work, scoring was made [Fousekis *et al.* 2011; Sangjan *et al.* 2017]. The total score range in LESS is between 0-19; Higher scores indicate poor landing biomechanics and an increased risk of injury. An excellent score (<4), a good score (≥4 but ≤5), a middle score (>5 but ≤6 ) bad score ( > 6) [Sangjan *et al*. 2017; Soligard *et al.* 2008].

### Statistical Analysis

In this study, SPSS version 25 package program was used for statistical analysis. Descriptive statistics of athletes were made, and the Shapiro Wilk Test was used to determine the normal distribution of groups. A non-parametric Mann-Whitney U test was used in two group comparisons. The level of meaning is determined as p<0.05.

### Results

Table 1' shows the LESS scores of wrestling and handball athletes, and the LESS scores of wrestling athletes were found to be lower than the handball athletes' LESS scores. There is no difference between the Total LESS scores between groups (u = 68,50 p = 0,712). A significant difference in knee flexion angle was found in the first contact compared to the LESS evaluations of athletes (u = 40,00 p = 0,016). At the point of contact between the athletes, there was a difference between the ankle plantar flexion scores (u = 50,00 p = 0.046). A significant difference was found among athletes in the position where the knee valgus displacement was inside the knee thumb (u = 45,00 p = 0,046).

**Table 1.** Comparison of less scores of wrestling and handball athletes

| | Wrestling Mean ± Ss | Hanball Mean ± Ss | U | P |
|---|---|---|---|---|
| **Total LESS Score** | 3,67 ± 1,71 | 4,50 ± 2,91 | 68,50 | ,712 |
| **Knee flexion angle >30 degrees in first contact; 0 = yes, 1 = no** | 0,13 ± 0,352 | 0,60 ± 0,516 | 40,00 | ,016* |
| **Ankle plantar flexion at the contact point; 0 = from head to toe; 1 = no** | 0,33 ± 0,488 | 0,00 ± 0,00 | 50,00 | ,046* |
| **Knee valgus displacement (knee position) before jumping, inside the knee thumb; 0 = no, 1 = yes** | 0,20 ± 0,414 | 0,60 ± 0,516 | 45,00 | ,046* |

•(p<0,05)

### Discussion

Health status is an important factor in the performance development of athletes. Orthopedic problems play a restrictive role in sustaining athletes' performance. Among these problems, the most common are injuries to the lower limb. Lower limb injuries can affect sporting performance as well as cause significant time loss for athletes during their treatment time. For this reason, it is important for athletes to identify injury risks and try to eliminate them [Arnason *et al.* 2004].

This study aims to compare the splash and landing mechanics of elite handball and wrestling athletes. Compared to wrestling and handball athletes, the main result of our study was that there were no statistically significant differences between the total LESS scores of 0,712 (p > 0,05). According to the research result, wrestling athletes had excellent (3,67 ± 1,71) LESS scores. Handball athletes had good (4,50 ± 2,91) scores. In a study with elite young basketball players, LESS scores decreased significantly thanks to the exercises integrated into the training program [Garbenyt Apolinskien *et al.* 2018]. In our study, the tests of the athletes were in the special preparation period of the training periods, and they applied the necessary strength exercises in the previous periods. For this reason, wrestling athletes are excellent, and handball athletes are also thought to have good scores. In our study, the scores of wrestling athletes were lower, and the risk of SEPA injury was found to be lower than that of handball athletes. Parsons *et al.* [2017] reported that muscle strength may indirectly affect LESS scores. Wrestling athletes participating in our work practice more strength training because of the nature of the branch. For this reason, it is estimated that he received better points than handballers.

Being able to reduce LESS scores is important to positively affect the splash landing mechanics. At the

same time, these methods, which can be applied in order to change the current situation positively and reduce the dangers of injury in cases where athletes are inadequate, are important for athletes. When the literature is examined to reduce LESS scores, it is available in different forms other than exercises. It was seen that the LESS scores of the athletes changed positively due to the visual feedback on the video. Athletes were registered during the test, and then visual feedback was given. As a result of the feedback, the test scores of the athletes decreased, resulting in a positively significant improvement [Benjaminse *et al.* 2017]. In addition, the use of ergogenic supports in sports is important for improving athlete performance. Wu *et al.* [2022] he examined the effects of dynamic taping on athletes' landing mechanics. As a result of their work, they reported that the athletes' dynamic taping contributed positively to the landing mechanics.

The Salcı [2021] compared LESS scores among elite young footballers. U15 players 5.43±2.86, U16 players 3.17±2.41, U17 players 2.04±2.07, U19 players had 4.87±2.30 points. When we compare our research with the scores of wrestling athletes, they are similar to those of U16 and U17 athletes. The scores of handball athletes are similar to those of U15 and U19 athletes.

Hendrik *et al.* In his study in 2023, among the handball, basketball, football, and hockey athletes who played in professional leagues in Germany between 2014 and 2018, the risk of injury to the high level of the ACL was determined compared to other athletes.

ACL, which determines the risk of injury, is critical to the continuity of athletes. There is also a requirement for a standardized test to reveal risks. LESS is a standardized and economical clinical evaluation method. In the studies conducted, it was revealed that LESS' is a reliable clinical study [Padua *et al.* 2009; Hanzlikova, Loiser 2020; Padua *et al.* 2011].

LESS is often applied in studies on the examination of athletes' splash landing mechanics, body composition, performance evaluations, and knee injury examinations [Barber Westin *et al.* 2006; Mc Lean *et al.* 2005; Noyes *et al.* 2005].

In the study of elite young football athletes in 2015, LESS was applied to a total of 829 athletes. Athletes were evaluated before and after the season. Athletes who experienced ACL injuries during the season had worse scores than athletes who did not experience injuries. This reveals the potential impact of "LESS" in predicting ACL injury [Padua *et al.* 2015].

It is obvious that the factors that reduce or increase LESS scores in the studies conducted are related to the risk of ACL injury. Fadei *et al.* [2021], 34 women conducted research with basketball, volleyball, and handball athletes. They determined that there was also poor lumbopelvic control among the elements that increased less. In their studies examining landing mechanics and muscle surface electromyography (EMG), they reported that EMG activations and LESS scores were negatively affected as lumbopelvic control decreased. There was no significant difference between the branches.

Kang [2017] examined the width of the cast force and joint movement in a study. When splashing landing mechanics were examined, poor muscle strength and falling ROMs in drop splash tests negatively affected the scores.

When the literature is examined, there are differences between the branches in terms of LESS scores. Some branches have superior splash-landing mechanics, while in others they are worse. Among the reasons for these, the movement dynamics of the branches can be effective, as can the level of the sample group applied.

Eriksson and Lundberg used the LESS test while examining knee stability in football and handball athletes in their 2014 work. A total of 20 athletes were included, both women and men. Considering the results of the study, although women received worse results than men in terms of knee waltz, there was no significant difference in total LESS scores. When comparing football and handball athletes by branch, they revealed that footballers had lower scores. In contrast, when the literature is examined by Hanzlikova *et al.* [2021], when they examine LESS scores by gender as a result of their metaanalysis, women have higher scores than men, revealing that they are more open to lower limb injuries.

Harato *et al.* [2021] examined the differences between the various sports activities in the biomechanical properties of the fall splash in female basketball, football, and volleyball athletes. As a result of the study, they stated that female volleyball and basketball athletes had higher LESS scores compared to female football athletes and had less knee flexion in knee waltz and first contact.

They reported that the branch that has the best scores and the best stability ability is gymnastics, according to the study results. Since the wrestling branch is the branch that intensely contains dynamic movements for the lower limb, such as the gym blush gymnastics, we have seen better splash-landing mechanics in our wrestling athletes compared to handballers. Similarly, in their study in Atan and Imamoglu [2012], 20 women and 20 men volleyball players and 20 men wrestling athletes were interviewed, for a total of 60 people. Although male volleyball players have superior scores than male wrestlers at the height of the jump, male wrestlers have willingly demonstrated that they are more successful in the jump-landing mechanics as a result of the overall assessment. Some studies also show that there are differences between styles in terms of splash landing mechanics [Flag, Haluk 2017]. Similarly, splash mechanics differences were detected between different positions in the handball branch [Kruger *et al.* 2014].

Studies on athletes have shown that LESS scores differ according to sports branches. There may also be

changes in the branches according to positions and styles.

Another result of our study is the knee flexion angle of 0.016 ($p<0.05$) at the first contact. When the LESS evaluations of wrestling and handball athletes are compared, ankle plantar flexion at the contact point was 0.046 ($p<0.05$), knee valgus displacement found significant differences in the knee thumb at 0.046 ($p<0.05$ ). Handball athletes have better results than wrestling athletes when evaluated in terms of ankle flexion at the point of contact. Wrestling athletes performed significantly more knee flexions in the first contact compared to handball athletes. The large knee flexion angle creates a larger knee flexion moment and a landing technique with a lower GRF( ground reaction force); consequently, a reduced risk of knee injury may occur [van der Does *et al.* 2016]. Wrestling athletes were found to be more advantageous as the increase in knee flexion during the fall reduced the load on the ACL. At the same time, wrestling athletes had better results compared to the knee waltz before jumping. Increased knee valgus angles have been associated with an increased risk of various knee injuries [Herrington 2011]. One of the important factors in the knee waltz is the activation of hip muscles. Wrestling athletes intensely practice movements such as squats, deadlifts, and hip thrusts in their general training compared to handball athletes. More strong hip muscles are thought to cause lower knee waltzes. [Sahabuddin *et al*. 2021].

## Conclusions

The most common injuries among handball and wrestling athletes are injuries in the lower extremities (ankle, knee, and thigh). In this study, which is aimed at determining the level of ACL risk, which is one of the most serious injuries that increases the healing process, there is no statistical difference between the LESS scores of wrestling and handball athletes. Although the athlete's injury risks were low in both branches, the wrestler's less scores were better, and the knee joint angles during jump-fall were statistically different compared to handball players. This may be due to the effect of takedowns and single-leg lifting movements, which are often used in wrestling, on the mechanics of the knee joint. The number of athletes participating in our study and the difference in the social lives of athletes constitute the limitations of the study. In future studies, more participants and comparisons of athletes from different age groups will make a positive contribution to the literature.

## Financial Source

During this study, from any pharmaceutical company that has a direct link to the subject of research, from a firm or any commercial firm that provides and/or manufactures medical instruments, supplies, and materials, no material and/or spiritual support was received, which could adversely affect the decision to be made regarding the study.

## Conflict of Interest

Regarding this study, the relationship of the authors and/or family members with scientific and medical committee membership or members who may have the potential for conflict of interest, consultancy, expertness, working status in any company, no shareholding, and similar situations.

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## Porównanie mechaniki lądowania i skoku elitarnych zawodników piłki ręcznej i zapasów

**Słowa kluczowe:** LESS (System punktacji błędnego lądowania), zapasy, piłka ręczna, skok, acl (więzadło krzyżowe przednie)

**Streszczenie**

Wprowadzenie. Badanie i wykrywanie przyczyn urazów stanowi ważną informację dla sportowców. Identyfikacja ryzyka urazów bezkontaktowych u zawodników, a następnie skierowanie ich do profilaktycznych programów ćwiczeń może być korzystne dla zdrowia sportowców.

Cel. Celem tego badania jest porównanie mechaniki lądowania po skoku elitarnych zawodników trenujących piłkę ręczną i zapasy.

Materiał i metody. Celem badań było porównanie mechaniki lądowania z wyskoku u elitarnych zawodników piłki ręcznej i zapasów. Do badań w prowincjach Bolu i Yalova zgłosiło się 10 piłkarzy ręcznych z 1. ligi (wiek 17,60±1,43 wzrostu 180,30±7,05 kg 76,40±5,29) i 15 zapaśników z kadry narodowej (wiek 25,87±3,18 wzrostu 178,67±8,64 kg. 77,13±14,16), łącznie 25 sportowców płci męskiej. Protokół testu Landing Error Scoring System (LESS) został zastosowany dla zawodników po wykonaniu skoku. Wykonano statystyki opisowe sportowców, a test Shapiro-Wilka został użyty do określenia normalnego rozkładu grup. Nieparametryczny test U Manna-Whitneya został użyty do porównania zawodników trenujących piłkę ręczną i zapasy.

Wyniki. Nie było różnicy między wynikami LESS zawodników piłki ręcznej i zapasów ($p > 0,05$). W porównaniu z ocenami LESS sportowców, stwierdzono znaczące różnice w kącie zgięcia kolana przy pierwszym kontakcie, punktacji zgięcia podeszwowego kostki w punkcie kontaktu i przesunięciu koślawości kolana ($p < 0,05$).

Wnioski. W niniejszym badaniu, które zostało przeprowadzone w celu określenia poziomu ryzyka związanego z więzadłem krzyżowym przednim (ACL), nie znaleziono statystycznej różnicy między wynikami LESS zawodników uprawiających zapasy i piłkę ręczną. Pomimo tego, całkowite wyniki LESS zawodników uprawiających zapasy okazały się niższe w porównaniu do zawodników uprawiających piłkę ręczną. Pokazuje to, że prawdopodobieństwo kontuzji jest niższe pod względem punktacji LESS. Fakt, że wynik wyszedł w ten sposób, pokazał, że zapaśnicy, którzy wzięli udział w badaniu, mieli lepsze kończyny dolne.